

## HFC-134a Direct Emissions from Vehicle Air Conditioning Systems

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Sacramento, CA

### Three Modes of Direct Lifetime Emissions

<u>Mode</u>	<u>Timing</u>	<u>When</u>
<b>Leakage</b> "regular"	gradual, continuous	in-use
<b>Accidental release</b> "irregular"	fast, discrete	in-use
<b>End-of-life release</b>	fast, once	post-use

### Existing MAC Emission Data

- Ford: 48-hr diurnal SHED testing vehicles and AC off
- Schwarz: Loss of charge over first (EC) 6 mo. to 6 yr. of life
- Stemmler: Avg. leak rate in a tunnel (Swiss)
- Others

Valid works; but narrow scopes for California fleet.

### California Alternative: Emissions by Mass Balance

- Over a vehicle's life:  
$$\text{Emissions} = \text{Net inputs}$$
$$= \text{initial charge} + \text{recharges} - \text{amount recovered at end}$$
- Net inputs: ~3 discrete events per veh.
- Data are accessible for many vehicles

### Data Sources

- **Number of recharges:** 12,000 vehicles in 9 fleets; surveys of 966 vehicle owners
- **System capacity and amount per recharge:** 288 evacuations & recharges
- **End-of-life recovery:** survey of dismantlers, discussions with USEPA & California reclaimers
- **Lifetime:** EMFAC (16 yrs.)

### Overview of Results

- Over 16-yr lifetime, the average California LDV emits ~1.4 kg of HFC-134a
- Results are basis for HFC inventory
- Includes releases & servicing fugitives
- This does not count:
  - excess emissions from "do-it-yourself" repairs
  - including emissions from topping Freon systems with HFC-134a

## Comparisons

	<u>Loss, grams/yr</u>
Measured leak rates* (Ford)	26
Long-term loss (EC)	53
Tunnel study (Swiss)	123
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ARB analysis	~85

\* vehicles & ACs not operating

## Caveats

- Our data are specific to the vehicle fleet of 2003
- HFC-134a LDVs still maturing
- We can't identify model-year effects
- Same analysis in a later year might give a different result

## Climate Change Equivalent Emissions

- ~85 gm/yr/HFC-134a vehicle
- Or ~9 CO<sub>2</sub>-equiv. gm/mile
- Of this, ~6 CO<sub>2</sub>-equiv. gm/mile are due to leakage

*Note:* 200,000 lifetime VMT, GWP=1300

## Opportunities for reducing leakage

- Compressor shaft seal
- Hoses
- Connections

Working with SAE's Interior Climate Control Standards Committee

## Final Remarks

- **Analysis quantifies nominal GHG direct emission contribution from existing MACs in California**
- **Results are consistent with available research literature**
- **Potential paths for reductions can be identified**

### References::

- 1) Staff Report, "HFC-134a Emissions from Current Light- and Medium-Duty Vehicles," CARB, Research Division, March 2004.
- 2) Vincent, R., Cleary, K., Ayala, A., and Corey, R., "Emissions of HFC-134a from Light-Duty Vehicles in California," **2004**, SAE Technical Paper 2004-01-2256.